Draft

Proposed Site-Specific Selenium Criterion for Hoopes Spring, Sage Creek, and Crow Creek near the Smoky Canyon Mine

April 2017

Prepared for:

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April 18, 2017

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RETURN RECEIPT REQUESTED

Mr. Don Essig
Water Quality Standards Coordinator
Idaho Department of Environmental Quality
1410 N. Hilton
Boise, ID 83706

Dear Mr. Essig:

As you are aware, the J.R. Simplot Company (Simplot) began work in 2006 studying the toxicity effects of selenium on the aquatic environment near the Smoky Canyon Mine. Specifically, field and laboratory studies were done focused on determining the selenium toxicity thresholds to brown (*Salmo trutta*) and Yellowstone cutthroat (*Oncorhynchus clarki bouvieri*) trout.

When Simplot initiated this work, the intent was to bring together a number of agencies and interested stakeholders, such as the Environmental Protection Agency, the U.S. Forest Service, the U.S. Fish and Wildlife Service, Idaho Fish and Game, the Wyoming Department of Environmental Quality, a regional conservation group, and the Idaho Department of Environmental Quality for the purpose of collaborating to determine the effects and toxicity thresholds of selenium in the aquatic environment adjacent to the Smoky Canyon Mine. Most of the aforementioned organizations (the U.S. Fish and Wildlife Service and the regional conservation group did not participate) provided reviews of study plans and detailed comments on the data obtained. The extensive participation by these agencies was integral to the success of these studies.

The data and results from all these studies was submitted to EPA in 2014 as a part of EPA's work towards developing a new national recommended fresh water quality selenium criterion. In particular, the brown trout study, was carefully reviewed for inclusion as a study to help calculate the new recommended criterion. In fact, the brown trout study underwent a couple of peer reviewed processes and extensive discussion of the study was included in EPA's 2016 criterion document. EPA calculated an EC_{10} based on survival (hatch to swim-up) of 21.0 mg Se/kg-egg dw that was used in calculating the recommended national criterion.

Simplot, utilizing the extensive studies conducted since 2006 and EPA's work in developing a recommended national criterion, is now petitioning the Department for a chronic site-specific water quality criterion for selenium in the waters adjacent to and near the Smoky Canyon Mine in southeastern Idaho. The water quality rules for the State of Idaho provide for the establishment of site-specific water quality criteria. The development of a proposal document and the proposed criteria itself has to meet the requirements found in the Idaho Administrative Code, IDAPA 58.01.02.275. In addition to the Idaho specific rules, guidelines within EPA's 2016 National Criterion were also considered in developing this site-specific criterion, such that it includes an egg/ovary criterion, whole body criterion, and water column criterion.

The proposal (enclosed) is based on meeting the rules set forth in IDAPA 58.01.02.275 and the recommended guidelines recently established as part of the 2016 National Criterion. The proposed criterion, 19.9 mg/kg egg dw, is based on the 5th percentile of a distribution of 14 species mean chronic toxicity values. The attached proposal provides details on the derivation of this site-specific criterion and an implementation methodology utilizing a tiered monitoring approach. The tiered monitoring approach is based on relationships developed between selenium in the egg tissues, whole body tissues, and the water column.

We look forward to working with the Department on this important proposal. Please contact me at 208.780.7365 for any questions with this petition.

Sincerely,

Alan L. Prouty
Vice President, Sustainability & Regulatory Affairs

Attachment (1)

C: w/attachment
Lisa Macchio, U.S. EPA
Dave Teuscher, IDFG
Sheri Stumbo, U.S. Forest Service

EXECUTIVE SUMMARY

Simplot is proposing a site-specific selenium criterion (SSSC) comprised of four elements for streams adjacent to its Smoky Canyon Mine in southeast Idaho. The chronic criterion is proposed to be applicable to the following areas (herein called "the Site"):

- Hoopes Spring channel downstream of the spring complex.
- South Fork Sage Creek downstream of the spring complex.
- Sage Creek downstream of the confluence of Hoopes Spring with Sage Creek to its confluence with Crow Creek.
- Crow Creek downstream of its confluence with Sage Creek to the Wyoming border.
- North Fork Sage Creek and tributaries (including Pole Canyon Creek).

Simplot's proposed SSSC (Table ES-1) is comprised of the U.S. Environmental Protection Agency (USEPA 2016a) four recommended criterion elements: an egg/ovary criterion, a whole-body or muscle criterion, a monthly average exposure value for water, and an intermittent exposure value for water.

Table ES-1. Summary of Proposed Site-Specific Selenium Criterion Elements

Media Type	Fish Tissue[1]		Water Column[45]	
Criterion Element	Egg/Ovary[2]	Fish Whole Body[3]	Monthly Average Exposure	Intermittent Exposure[7]
Magnitude	19.9 (mg/kg dw) egg	13.63 (mg/kg dw) whole body	13.55 (µg/L) in lotic aquatic systems	$WQC_{int} = WQC_{30day} - C_{background}(1 - f_{int}) / f_{int}$
Duration	Instantaneous measurement	Instantaneous measurement	30 days[6]	Number of days/month with an elevated concentration
Frequency	Not more than once in three years on average	Not more than once in three years on average	Not more than once in three years on average	Not more than once in three years on average

mg/kg dw = milligrams per kilogram dry weight

ug/L – micrograms per liter

Table Notes:

1. Fish tissue elements are expressed as an arithmetic average of tissue concentrations from at least five individuals of the same species and similar size.

2. Egg/ovary supersedes any whole body, muscle, or water column element when fish egg/ovary concentrations are measured.

3. Fish whole body tissues supersede water column element when both fish tissue and water concentrations are measured.

4. Water column values are based on total selenium concentrations and are derived from fish tissue values using the empirical bioaccumulation factor (BAF) approach and a site-specific dissolved to total concentration translator (0.98).

5. The water column value is to be used when no fish tissue data are available, or in rare cases of fishless waters. The egg threshold supersedes any whole body or water column elements when fish egg concentrations are measured.

6. The monthly average can be based on a single or multiple days of monitoring within a 30-day period. The geometric mean is used as the average.

7. Where the water quality criterion 30-day ($WQC_{30\text{-}day}$ is the water column monthly element for either lentic or lotic waters; $C_{background}$ is the average background selenium concentration; and f_{int} is the fraction of any 30-day period during which elevated selenium concentrations occur, with f_{int} assigned a value ≥0.033 (corresponding to 1 day).

The proposed egg criterion (19.9 mg/kg dw) is based on the 5th percentile of a distribution of 14 species mean chronic values (SMCVs)[1]. The most sensitive species in this distribution is brown trout (i.e., EC_{10} 20.5 mg/kg dw egg selenium) derived from wild trout collected from within the Study Area. From the egg criterion, a whole body tissue concentration equivalent was derived based on a conversion factor (CF) of egg selenium to whole body selenium calculated at 1.46. The resulting whole body tissue element (13.63 mg/kg dw)[2] can be used as a compliance monitoring measure if egg tissue data are not available.

The water element is based on the empirical Bioaccumulation Factor (BAF) approach cited by USEPA (2016a) as one of two acceptable approaches for deriving a water value from an egg tissue criterion. A median BAF was derived from paired brown trout tissue data and dissolved selenium concentrations measured at the time of fish tissue collection at several locations within the Site from 2006 to 2011. Because the brown trout tissue data were for whole body, each value was converted to an egg concentration using the above-mentioned CF. The median whole body to egg converted BAF was derived (1.499) and divided into the egg criterion value (19.9 mg/kg dw) yielding a dissolved water element value of 13.28 µg/L. Because the State of Idaho expresses its standards on a total concentration basis, the value was converted to a total

[1] This differs from the 2016 National Criterion which is based on N = 15 genus mean chronic values (GMCVs) resulting in an egg criterion of 15.1 mg/kg dw selenium.

[2] The USEPA (2016a) whole body value for brown trout (13.2 mg/kg dw), is slightly lower but the proposed site-specific whole body value is based on a more robust data set that is specific to the Site.

concentration using a site-specific dissolved to total metal translator ratio (0.98) which results in a water criterion element of 13.55 µg/L. The water element, being derived from the egg criterion, can be used for compliance monitoring, but if exceedances of the water element occur, then follow up monitoring should include whole body tissue monitoring to assess if the whole body tissue criterion is exceeded.

1.0 INTRODUCTION

The J.R. Simplot Company (Simplot) is proposing a chronic site-specific selenium criterion (SSSC) for several streams adjacent to its Smoky Canyon Mine that are influenced by discharges of groundwater with elevated selenium concentrations (Figure 1). Simplot's Smoky Canyon Mine is located in Caribou County, in the southeast corner of Idaho, approximately 10 miles west of Afton, Wyoming and 23 miles east of Soda Springs, Idaho. The mine is situated on the eastern edge of the Webster Range overlooking Sage Valley to the east. Site-affected groundwater discharges at Hoopes Spring and South Fork Sage Creek Springs, which are located in the foothills transitioning into Sage Valley east of the Smoky Canyon Mine. Water from both springs flows into Sage Creek. Sage Creek flows into Crow Creek which flows north, northeast and crosses the Idaho-Wyoming state line before discharging into the Salt River. These cold water streams are east trending or north to northeast trending and range from moderately high to low gradients.

Development of site-specific criteria is supported by guidelines and processes outlined in state and federal regulations, which are described in more detail below. Currently, the State of Idaho's water quality standards include a chronic selenium criterion of 5 µg/L (based on USEPA 1987). The criterion was based on bluegill sunfish in lentic habitats which are not found in southeast Idaho. Literature reviewed early on in the process suggested that different species have different sensitivities to selenium (Lemly 1997; Holm et al. 2005; Hardy 2005; Gillespie and Baumann 1986; Coyle et al. 1993; Kennedy 2000; USEPA 2004). Further, differences in lotic (i.e., flowing waters) or lentic (i.e., standing waters) habitat conditions influences selenium speciation (e.g., selenate versus selenite). These observations reflect the geochemical behavior of selenium in the environment. Selenite, a more bioavailable and toxic form, is dominant in lentic habitats, whereas selenate, a less bioavailable and less toxic form of selenium, is dominant in lotic habitats. Additional studies suggested that cold water species (i.e., trout) were less sensitive to selenium than were warm water species (i.e., bluegills). Collectively, the geochemical behavior of selenium in the aquatic environment and sensitivity of different species suggested that developing an SSSC was appropriate for streams adjacent to the Smoky Canyon Mine.

Simplot began a series of scientific studies into the effects of selenium on trout in local streams in 2006. As part of the initial efforts to develop an SSSC, a Work Group[3] was convened comprised of state and federal technical experts, regulatory personnel, and Simplot representatives. The Idaho Department of Environmental Quality (IDEQ) led the SSSC Work Group, which provided valuable input into planning and development of the field and laboratory studies, reviews of documents, and on the direction of the SSSC development process. A combination of laboratory and field studies were conducted from 2006 to 2008 to develop the data necessary for developing an SSSC. In addition, continued literature reviews were conducted to compile up to date information on selenium toxicity in fish and aquatic biota. Collectively, these studies have become the basis for proposing an SSSC for the Site streams.

The criterion proposed herein is the culmination of many years of compiling and analyzing site-specific and non-site-specific data by Simplot, USEPA, and others. Release of the *Aquatic Life Ambient Water Quality Criterion for Selenium – Freshwater-2016* (USEPA 2016a) (hereafter referred to as the 2016 National Criterion) has further guided the SSSC development process by providing a more complete understanding of how USEPA intended to implement the selenium criterion as a tissue-based value, and how the effects data are integrated to collectively arrive at a single criterion value. Using the approaches described in USEPA (2016a) and the site-specific data, this proposal provides a criterion protective of aquatic species.

This SSSC proposal is organized into the following sections:

- Section 2 – Setting, Study Area, and Scope of Applicability
- Section 3 - Regulatory Requirements for Developing an SSSC
- Section 4 - Background and Chronology for the Current SSSC proposal
- Section 5 – Site-Specific Studies and Literature
- Section 6 – Development of a Site-Specific Criterion
- Section 7 –Proposed Criterion Implementation
- Section 8 - References

[3] The SSSC Workgroup is comprised of representatives from Idaho Department of Environmental Quality (IDEQ), Idaho Department of Fish and Game (IDFG), United State Environmental Protection Agency (USEPA), Unites States Forest Service (USFS), Wyoming Department of Environmental Quality (WDEQ), and Simplot.

2.0 SETTING, STUDY AREA, AND SCOPE OF APPLICABILITY

2.1 Setting

The Smoky Canyon Mine is located in Caribou County, Idaho, within the Southeastern Idaho Phosphate Mining District. Phosphate ore is extracted from the Phosphoria Formation in a series of open pits referred to as mine panels. Elevations at the mine range from 6,500 feet to 8,300 feet above mean sea level (AMSL). Slopes drain generally eastward, with streams flowing into the Salt River which flows to the Snake River. The closest main population center to the mine is the Star Valley community, which includes the town of Afton, Wyoming, approximately 10 miles directly east of the mine. The town of Afton has a population of approximately 1,900 (U.S. Census Bureau 2013). Caribou County has a cool and dry climate, with typical prevailing winds and weather patterns moving from west to east. Annual precipitation is typically in the range of 20 to 35 inches per year. The most abundant precipitation occurs in the spring and early summer months. In the winter months, snowfall averages 100 inches each year, and snow cover typically remains on the ground from November to March or April. Summer temperatures in the region normally range from 44 to 82 degrees Fahrenheit, while winter temperatures typically range from 4 to 28 degrees Fahrenheit (Mariah 1988). The Smoky Canyon Ecological Risk Assessment provides a detailed description of the wildlife and plant species found in the area (Formation 2016).

2.2 Study Area

Investigations at the nearby Smoky Canyon Mine, have identified elevated concentrations of selenium in groundwater discharging to surface water via Hoopes Spring and South Fork Sage Creek Springs. The source of selenium to groundwater is overburden generated by historical mining operations. Primary areas affected by elevated selenium concentrations where Hoopes Spring and South Fork Sage Creek Springs discharge are: Hoopes Spring downstream of the spring complex; Sage Creek from its confluence with the Hoopes Spring discharge channel to its confluence with Crow Creek; South Fork Sage Creek below the spring complex; and Crow Creek from its confluence with Sage Creek to the Idaho and Wyoming state line[4] (Figure 2).

[4] More recent monitoring data have indicated that selenium concentrations in surface waters of Crow Creek in Wyoming beyond the Idaho state line have exceeded the 5 µg/L standard.

To characterize the streams influenced by the groundwater discharges, field monitoring was conducted at a number of locations within the Study Area (Figure 3).

- Four background locations – three on Crow Creek and a single location on Deer Creek, each upstream of Sage Creek; and
- Six locations from the Site – two on Hoopes Spring, two on Sage Creek, and two locations on Crow Creek downstream of Sage Creek.

A single reference site outside of the Crow Creek drainage was also monitored at South Fork Tincup Creek.

The Smoky Canyon Mine area and nearby Sage Valley to the east contain several perennial streams and two large springs: Hoopes Spring and South Fork Sage Creek Springs. Average daily high and low flows in the Hoopes Spring channel are 8.36 and 6.34 cubic feet per second (cfs), respectively. The source of water is discharging regional groundwater and flows have been observed to be nearly constant over years of monitoring. Downstream of the South Fork Sage Creek Springs, average daily high and low flows are 10.7 and 8.47 cfs, respectively, which have also been relatively constant. Unnamed springs with lower flows are found in other parts of the Study Area (these do not have elevated concentrations of selenium).

In general, stream flows are low and the creeks do not transport large quantities of sediment except during spring-runoff conditions when creeks may become more turbid. Sediment conditions are generally characteristic of headwater creeks with benthic substrates ranging from near bedrock to sand and cobbles covered by small boulders. Many creeks have notable amounts of fine particles, which result in moderate to high embeddedness of cobbles and small boulders. Fine sediment loads have historically been due to grazing activities in these watersheds where livestock trample banks and denude riparian vegetation. Recent steps to mitigate these effects have been undertaken by Simplot, USFS, and private landowners by fencing off stream areas from livestock use, and resulting improvements in stream bank stability have been noted through routine monitoring. Mining operations do not generally affect sediment conditions because storm water catch basins are utilized to inhibit off-site migration of particles.

Based on the most current State of Idaho 303(d) list of impaired waters cited in the State Integrated Report, North Fork Sage Creek, Pole Canyon Creek, South Fork Sage Creek, and Sage Creek downstream of North Fork Sage Creek are listed as impaired due to selenium (IDEQ 2017). Crow Creek, Sage Creek, and South Fork Sage Creek are listed for non-contaminant impairments such as bacteria, sedimentation, and/or habitat issues. The creeks within the Sage Creek basins are subject to IDEQ water quality standards for their designated uses. All surface waters within the Study Area are designated for cold-water biota use. Water quality conditions in these basins are generally characterized by moderate hardness, low concentrations of suspended solids, and circumneutral pH conditions.

Perennial streams within the Study Area contain several species of fish and a wide variety of aquatic macroinvertebrates. Overall, the fishery appears to be in fair to good condition at most locations with adequate fish densities, good condition factors, few abnormalities, multiple life stages, and expected species diversity (NewFields 2009). Fish species commonly encountered include: brown trout (*Salmo trutta*), Yellowstone cutthroat trout (*Oncorhynchus clarkii ssp.*) (YCT), longnose dace (*Rhinichthys cataractae*), redside shiner (*Richardsonius balteatus*), Utah sucker (*Catostomus ardens*), Paiute sculpins (*Cottus beldingi*), mottled sculpin (*Cottus bairdi*), speckled dace (*Rhinoichthys osculus*), and mountain whitefish (*Prosopium williamsoni*).

Less common species, that have been found include: brook trout (*Salvelinus fontalis*), rainbow trout (*Onchorhyncus mykiss*), and leatherside chub (*Gila copei*). Amphibian and reptile species known to occur in the Study Area include tiger salamander (*Ambystoma tigrinum*), boreal chorus frog (*Pseudacris maculata*), rubber boa (*Charina bottae*), and western terrestrial garter snake (*Thamnophis elegans*).

Hoopes Spring and Sage Creek near Hoopes Spring are trout and sculpin dominated systems. Brown trout is the dominant trout species, but YCT are found throughout Hoopes Spring and Sage Creek. Farther downstream in Sage Creek, near Crow Creek, mountain whitefish are occasionally found. In Crow Creek downstream of Sage Creek, sculpins are found less frequently, while longnose and speckled dace are commonly found together with redside shiner. Utah suckers are also found in large deep pools.

Paiute sculpin has been almost exclusively found, with occasional mottled sculpins collected intermittently. One leatherside chub was found in 2008 in an upper reach of Crow Creek. Dace species are typically found in the lower elevation Crow Creek areas whereas sculpin are predominant in the upper elevation reaches of Sage Creek and Crow Creek. Redside shiner and Utah Sucker are also found in the lower elevation reaches.

2.3 Scope of Applicability

A proposal for an SSSC must define the geographic scope or area to which the criterion would apply. In the general context of site-specific criteria, a "site" may be a state, region, watershed, water-body, or segment of a water body. The site-specific criterion is to be derived to provide adequate protection for the entire site, however the site is defined (USEPA 1994). The geographic scope of applicability for the proposed criterion is for Sage Creek and tributaries and Crow Creek from Sage Creek to the Wyoming State line (the Site) (Figure 3).

The water bodies being investigated are found within the Salt Subbasin, HUC 17040105, of the Upper Snake River Basin. Two subunits of the Salt subbasin are potentially affected, including water body US-9 (Sage Creek – source to mouth) and water body US-8 (Crow Creek – source to Idaho/Wyoming border) as defined by the Idaho Administrative Code's Water Quality Standards (IDAPA 58.01.02).

IDEQ's 2014 Integrated Report (IDEQ 2017) identifies specific stream segments as being limited by one or more parameters that affect use attainment. Within the Integrated Report, hydrologic subunits are defined to identifying specific stream segments. These numeric stream segment identifiers from the Integrated Report are shown below together with a narrative description of where the SSSC would apply within each stream segment.

Sage Creek and its tributaries include the following stream segments (Figure 3):

- ID17040105SK009_02e South Fork Sage Creek (7.93 miles) – applied to South Fork Sage Creek below the spring complex.

- ID17040105SK009_03 Sage Creek – confluence with North Fork Sage Creek to mouth (3.22 miles) – applied to this entire segment.

- ID17040105SK008_04 Crow Creek – Deer Creek to border (10.42 miles) – applied to Crow Creek downstream of Sage Creek confluence to the Wyoming border.

- Hoopes Springs – no specific segment is identified; it falls within the larger segment identified above for Sage Creek.

- ID17040105SK009_02 North Fork Sage Creek (12.41 miles); and

- ID17040105SK009_02d Pole Canyon Creek (3.6 miles)

Monitoring locations characterized as part of these site-specific studies are representative of streams in the area; therefore, while some specific streams were not characterized, the proposed SSSC is likely applicable and appropriate given the common sources, water quality, and proximity within the basin. For example, while the North Fork Sage Creek was never sampled as part of the SSSC studies, it is a source to Sage Creek and includes common water quality and aquatic species. The primary source of selenium to North Fork Sage Creek is Pole Canyon Creek, which only reaches the North Fork Sage Creek occasionally during high flow spring runoff conditions.

Few site-specific criteria have been developed in Idaho. In the Coeur d'Alene basin, site-specific criteria were developed for cadmium, lead, and zinc in the upper South Fork, but there was a need to apply the criteria to lower sections of the South Fork and the main stem. Authors of the site-specific document argued that part of the rationale for expanding site-specific criteria to downstream reaches of the South Fork was based on the application of site-specific chemical, biological, and toxicological data to factors affecting metals toxicity in freshwater (Bergman and Dorward-King 1997). The ecological principle of the stream continuum provides a context for understanding watershed biogeochemistry and species distributions, that factors into the evaluation (Vannote et al. 1980). The same arguments also hold true for Sage Creek and Crow Creek. Data developed as part of these site-specific studies suggest that the SSSC is applicable to locations both upstream and downstream of Hoopes Spring. Further, the SSSC proposed is applicable to Crow Creek downstream of Sage Creek based on the application of site-specific chemical, biological, and toxicological data to factors affecting selenium toxicity in this system.

3.0 REGULATORY REQUIREMENTS FOR DEVELOPING AN SSSC

The Clean Water Act (CWA) found in the Code of Federal Regulations (CFR) includes a provision (i.e., 40 CFR 131.11(b)) that allows for establishing site-specific water quality criteria. USEPA has delegated enforcement of the CWA to the State of Idaho, including decision-making related to the development of site-specific criteria.

The State of Idaho has specific requirements to be followed for developing a site-specific criterion (Idaho Administrative Code, IDAPA 58.01.02.275). Two that particularly apply are:

1) (275.01.a.i) "Resident species of a water body are more or less sensitive than those species used to develop a criterion," and

2) (275.01.a.ii) "Biological availability and/or toxicity of a pollutant may be altered due to differences between the physicochemical characteristics of the water in a water body and the laboratory water used in developing a water quality criterion (e.g., alkalinity, hardness, pH, salinity, total organic carbon, suspended solids, turbidity, natural complexing, fate and transport water, or temperature)."

Because the current State of Idaho standard is based on species not present in southeast Idaho, and the Study Area characteristics are different than those conditions from which the standard was derived, the conditions are appropriate for developing a site-specific criterion. Further, IDAPA 275.01.b specifies that:

> "Any person may develop site-specific criteria in accordance with these rules. To ensure that the approach to be used in developing site-specific criteria is scientifically valid, the Department shall be involved early in the planning of any site-specific analyses so that an agreement can be reached concerning the availability of existing data, additional data needs, methods to be used in generating new data, testing procedures to be used, schedules to be followed and quality control and assurance provisions to be used. (8-24-94)."

To fulfill this requirement, the IDEQ facilitated a series of meetings in which various state and federal environmental and resource agency scientists (i.e., SSSC Work Group) met and reviewed study plans and study results compiled over a period of approximately three years. IDEQ and associated agencies were engaged early and often in the process of compilation and analyses of Site data to ensure the application of sound scientific principles.

Acceptable procedures for developing a site-specific criteria are identified in IDAPA 275.01.h of the rule:

> i -"Site-specific analyses for the development of new water quality criteria shall be conducted in a manner which is scientifically justifiable and consistent with the assumptions and rationale in "Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses, USEPA 1985" (herein after referred to as Stephan et al 1985); and,
>
> ii – "Site-specific analyses for the modification of existing water quality criteria shall be conducted in accordance with one of the following procedures, as described in the *Water Quality Standards Handbook*

USEPA's *Draft Technical Support for Adopting and Implementing EPA's 2016 Selenium Criterion in Water Quality Standards* (USEPA (2016b) indicates that the recalculation procedure should be used for site-specific fish tissue criterion development. In addition, it also recommends that USEPA's (2013) revised deletion process be used in conjunction with the recalculation procedure. The procedure allows for recalculating a criterion based on species known to be present or not present at a site or for a region, or for use of surrogate species that result in differences in sensitivity between site species and those used to derive the 2016 National Criterion. It is basically a deletion process. USEPA (2013) describes a systematic manner where species are retained or deleted based on taxonomic rank for the purposes of deriving a species sensitivity distribution (SSD).

Once the species for criterion development are assembled, the chronic values are ranked and the four lowest genus or species mean chronic values (SMCVs) are used to derive the criterion. USEPA (2106a) indicates that the egg-ovary final chronic value (FCV) is calculated from regression analysis of the four most sensitive genus mean chronic values (GMCVs); in this case extrapolating to the 5th percentile of the distribution represented by the tested genera. The FCV directly serves as the fish tissue egg-ovary criterion concentration element without further adjustment because the underlying EC_{10} values (effective concentration causing a 10 percent effect on population) represent a low level of effect (per the EPA Ambient Water Quality Criteria Guidelines). The methods for this derivation are described in Stephan et al. (1985).

4.0 BACKGROUND AND CHRONOLOGY FOR THE CURRENT SSSC PROPOSAL

With over 10 years in the making, the chronology of events that have resulted in the present day SSSC proposal become an important facet in understanding the development process.

- August 2006 to August 2008 – Field data collection and laboratory studies.

- August 2010 – A *Draft Interpretive Findings for Field and Laboratory Studies and Literature Review in Support of a Site-Specific Selenium Criterion* (Interpretive Report) (NewFields 2010) was submitted to the SSSC Work Group for review and solicitation of comments.

- March 2011 – The SSSC Work Group was informed by USEPA Region 10 that the United States Fish and Wildlife Service (USFWS) would provide comments on Simplot's Draft Interpretive Report (August 2010; NewFields 2010).[5]

- January 2012 – Simplot submitted its Proposed SSSC and a Technical Support Document (TSD)[6] (Formation 2012) to the IDEQ and the SSSC Work Group. The EC_{10} proposed for egg/ovary, based on survival for brown trout fry, was 20.8 milligrams per kilogram (mg/kg) dry weight (dw).

- January 2012 – The USFWS submitted its technical review, authored by Dr. Joe Skorupa, of the Draft Interpretive Report to the USEPA and published its review on the USFWS website. The USFWS review primarily focused on the Brown Trout Adult

[5] Involvement of the USFWS came at the direction of the United States Senate Committee on Environment and Public Works chaired by Senator Barbara Boxer. In March 2011, Senator Boxer sent a letter to Mr. Rowan Gould, Acting Director of USFWS, and to Ms. Lisa Jackson, Administrator of the USEPA. In the letter to Director Gould, Senator Boxer requested that scientists in the USFWS review the described document and provide "technical assistance" to the Committee on Environment and Public Works. In the letter to Administrator Jackson, Senator Boxer requests that USEPA "consider, and where relevant, integrate federal assistance from federal scientists from outside of the agency." The letter then states that the Committee on the Environment and Public Works will forward this information to USEPA. It should also be noted that when the SSSC Work Group was formed, USFWS was invited to join but did not do so.

[6] The Technical Support Document (TSD) is the revised Draft Interpretive Findings for Field and Laboratory Studies and Literature Review in Support of a Site-Specific Selenium Criterion (Interpretive Report). Revisions to the Interpretive Report were made to incorporate comments provided by the SSSC Workgroup.

Reproduction studies,[7] generating several questions about the study and the endpoints derived.

- December 2012 – Due to questions raised in the USFWS review, USEPA contracted the Eastern Research Group (ERG) to conduct a peer review of their analyses that utilized the Brown Trout Study data in the context of questions raised by USFWS. The result of this effort was the *External Peer Review of the Interpretation of Results of a Study on the Effect of Selenium on the Health of Brown Trout Offspring* (ERG 2012). In this document, six experts were charged with addressing five specific questions raised by the USFWS review.

- April 2013 – Simplot submitted responses to the USFWS comments to the SSSC Work Group and USEPA. Included within the comment responses were two attachments: (1) *Data Quality Assurance Report: Reproductive Success Study with Brown Trout (Salmo trutta)* (AECOM 2012); and (2) Count of Normal Fish and Total Number of Fish for Each Sample from the Deformity Assessment. These additional data were included in the responses to comments to provide additional information to USEPA and other reviewers who were using the brown trout study data to derive EC_{10} values from that study for survival and deformities.

- June 2014 – USEPA altered some of its analyses to make use of the additional data submitted. Again, USEPA contracted for a Peer Review of pertinent questions regarding the revised analyses of the brown trout data. The result of that effort was the document titled *External Peer Reviewer Comments on Review of Draft USEPA Report, Analysis of the Brown Trout Selenium Toxicity Study Presented by Formation Environmental and Reviewed By U.S. Fish And Wildlife Service (June 2014)* (GLEC 2014). Similar to the previous peer review, six experts were charged with addressing five specific questions posed by USEPA about the analyses conducted.

- May 2014 – USEPA released its *External Peer Review Draft Aquatic Life Ambient Water Quality Criterion for Selenium – Freshwater 2014* (USEPA 2014). USEPA cited

[7] The focus on the brown trout studies was the result of the initial analyses in the Interpretive Report that indicated brown trout were more sensitive to selenium than Yellowstone cutthroat trout.

a range of egg/ovary thresholds derived from the brown trout data that ranged from 15.91 to 21.16 mg/kg dw egg selenium. This range was based on three different endpoints (survival, deformities, and a combined endpoint of survival and deformities). USEPA used the most conservative EC_{10} (15.91 mg/kg) as the brown trout value.

- July 2014 – Simplot, along with a number of other agencies, and other private firms and individuals, provided comments on USEPA's Draft Peer Review document. The ERG was subsequently contracted to conduct a peer review of the 2014 Draft National Criterion. Seven reviewers provided their expert opinions on questions posed by USEPA and ERG regarding the 2014 Draft National Criterion, the results for which are compiled in the *External Peer Review of the Draft Aquatic Life Ambient Water Quality Criterion for Selenium – Freshwater 2014* (ERG 2014).

- July 2015 – USEPA released a Draft National Criterion for selenium and presented an alternative threshold value for brown trout using only the survival endpoint which resulted in a value of 18.09 mg/kg dw egg selenium.

- July 2016 – USEPA released *Aquatic Life Ambient Water Quality Criterion of Selenium – Freshwater-2016* (USEPA 2016a), herein referred to as the 2016 National Criterion. Further reanalysis of the brown trout data resulted in an EC_{10} of 21 mg/kg dw egg selenium.[8] The survival endpoint data utilized was based on the data from hatch to swim up.

- September 2016 – USEPA released a series of draft implementation guidance (IG) documents and frequently asked questions (FAQ) documents to compliment the 2016 National Criterion. These draft IG and FAQ documents include the following:

    1. *Draft Technical Support for Adopting and Implementing EPA's 2016 Selenium Criterion in Water Quality Standards* (USEPA 2016b);
    2. *Technical Support for Fish Tissue Monitoring for Implementation of EPA's 2016 Selenium Criterion – Draft* (USEPA 2016c);

[8] See Appendix C of the 2016 National Criterion of EPA's analysis and rationale for the brown trout EC10 of 21 mg/kg dw egg selenium.

3. Frequently Asked Questions (FAQs): *Implementing the 2016 Selenium Criterion in Clean Water Act Sections 303(d) and 305(b) Assessment, Listing, and Total Maximum Daily Load (TMDL) Programs - Draft* (USEPA 2016d); and
4. *Frequently Asked Questions (FAQs): Implementing Water Quality Standards (WQS) that Include Elements Similar or Identical to EPA's 2016 Selenium Criterion in Clean Water Act Section 402 National Pollutant Discharge Elimination System (NPDES) Programs – Draft* (USEPA 2016e).

This chronology of events demonstrates (1) the level of scientific and regulatory examination by USEPA, USFWS, and a number of external peer reviewers on the brown trout data and interpretation, which were subsequently used in development of the 2016 National Criterion; and (2) the process and timing for developing the 2016 National Criterion and subsequent implementation guidance. The brown trout data provide an important threshold for the 2016 National Criterion, as they represent the third most sensitive species, preceded by white sturgeon and bluegill sunfish; two species not found in the vicinity of the Study Area. For this SSSC, the brown trout data provide an even more important threshold, as they represent information for the most sensitive species.

5.0 SITE-SPECIFIC STUDIES AND LITERATURE

To develop the science necessary for an SSSC, Simplot undertook a series of field studies that characterized species, communities, and populations, ambient exposure levels in water, sediment, dietary items, and physical and chemical characteristics of the Study Area streams. Laboratory studies were conducted to assess responses of two primary management species to selenium exposure and maternal transfer. An ongoing task has included review of available peer reviewed and gray literature, which has been used to guide the design for and augment the findings of the field and laboratory studies,

The laboratory studies using brown trout and YCT provided the response data necessary to derive an SSSC. Field monitoring studies provided for characterization of the exposure environment, the condition of the aquatic community, and the physical habitat. While the findings of the field monitoring studies are not used directly in the derivation of an SSSC, they do provide additional support for the criterion. The literature review provided response data for other species that may be similar to species within the Study Area that were not tested as part of Simplot's studies.

5.1 Laboratory Studies

Simplot conducted three laboratory studies to assess the effects of selenium in trout species present in the Crow Creek watershed. Two reproduction studies evaluated maternal transfer of selenium and its effects on developing young brown trout and YCT. A third study, early life stage (ELS), evaluated the effects of selenium from aqueous and dietary exposure to developing young YCT that had no maternal selenium transfer. A brief description of the brown trout and YCT maternal transfer studies are provided below because of the importance of these studies in developing an SSSC.

The maternal transfer studies evaluated adult reproduction of wild trout from the Study Area and effects on developing young in a controlled laboratory setting. These studies were conducted independently, with one study using brown trout and the second using YCT. Trout were collected from different locations within the Study Area (Figure 3), covering a range of selenium exposure conditions during respective species spawning times. Eggs from females were fertilized in the field and transported to the laboratory for rearing. Method controls for the study were hatchery-raised fish. The full methods and results of these investigations are reported in the TSD (Formation 2012) and AECOM (2012):

- *Appendix D - Final Brown Trout Laboratory Reproduction Studies Conducted in Support of Development of a Site-Specific Selenium Criterion* (Formation 2011)
- *Appendix E – Yellowstone Cutthroat Trout Adult Laboratory Reproduction Studies* (Formation 2012)
- *AECOM - Reproductive Success Study with Brown Trout (Salmo trutta). Data Quality Assurance Report. Final. December 2012*

For both species, the effects of maternal selenium transfer in wild trout were evaluated by collecting eggs from females and milt from adult males from different locations representing a range of selenium exposure. Eggs were fertilized in the field and sent to the laboratory for rearing. Effects analyses evaluated egg selenium concentration versus survival, deformity, and growth endpoints. Data from both of these studies were submitted to USEPA for use in their derivation of the 2016 National Criterion.

As noted previously, Simplot's brown trout studies have been through numerous and rigorous evaluations. Recent reanalysis of the brown trout data by Simplot and USEPA (2016a) yielded EC_{10} values for survival of 20.5 and 21 mg/kg dw, respectively, using slightly different data sets.[9] While an EC_{10} was developed for the deformity data, the uncertainty in the predicted EC_{10} was high enough due to data variability that the survival endpoint was used as the primary effects endpoint.

Of the relationships evaluated for YCT, percent survival (hatch to test end) provided the best relationship to egg selenium concentrations. Relying solely on the model output, the EC_{10} value was greater than 35 mg/kg dw egg selenium. Despite the use of multiple approaches and data transformations, clear dose response models using these effects endpoints were few. YCT data showed highly variable responses to egg selenium concentrations. Examination of the data distribution, however, did suggest differences in responses between 22.3 and 27.9 mg/kg dw egg selenium. A decreased response was noted at egg selenium concentrations greater than 27.9 mg/kg dw for both survival and growth. Averaging the observed no-effect and potential effect

[9] USEPA (2016) used the brown trout survival hatch to swim up portion of the data set, while Simplot's reevaluation of the data, using similar methods as USEPA but using the survival to test termination portion of the dataset resulted in a slightly lower EC_{10}. Both USEPA (2016) and Simplot's reanalysis of the brown trout data utilized USEPA's Toxicity Relationship Analysis Program (TRAP) (version 1.30a) (U.S. EPA 2013).

concentrations resulted in a value of 25.1 mg/kg dw, which is expected to be lower than a derived EC_{10}. Effects for egg selenium exposure on survival and deformities for YCT are at some concentration greater than 25 mg/kg dw in eggs.

The YCT data were reevaluated in 2014 and again in 2017 using a combined endpoint for surviving fry with no deformities. This endpoint for the YCT studies was proposed to USEPA in comments sent on the 2014 Draft Criterion, similar to their endpoint used for brown trout in the 2014 Draft Criterion. Reevaluation of these data in 2017 focused on the endpoint, surviving and normal, but used only the swim up portion of the test (Appendix A). One data point had an egg selenium concentration of 47.6 mg/kg dw and survival at >80 percent, which is not consistent with all the remaining YCT, brown trout, or cutthroat trout data from other studies. This data point was removed from the analysis and triangular distribution dose response model in TRAP was run yielding an EC_{10} of 28.62 mg/kg dw (lower confidence limit [LCL] = 27.29, upper confidence limit [UCL] = 30.00). A second dose response curve and EC_{10} was derived based on further refinement of the dataset[10]. The EC_{10} for YCT surviving and normal fry from hatch to swim up was 28.39 ([LCL] = 27.07, [UCL] = 29.78) mg/kg dw egg selenium (Figure 4). There is clear variability in both the low exposure "hatchery fish" and higher exposure Study Area fish, which is indicative of the types of responses likely to occur from wild runs of fish. Censoring the additional two data points provided for a better overall model fit, a slightly more conservative EC10, and eliminated from the analysis "control" wild fish that had poor hatching success, possibly due to poor fertilization. The resulting EC_{10} is consistent with the cutthroat trout data from the literature.

These analyses indicate that brown trout and YCT responses to selenium exposure are different. Brown trout are more sensitive in their response to maternally-accumulated selenium and its effects on developing young than are YCT. This finding is consistent with studies that have utilized several different trout species indicating sensitivity differences among similar species

[10] The second dose response curve for YCT combined endpoint presented herein included censoring (e.g., removal) 2 additional data points from the analysis. Closer examination of the data set showed that eggs from two hatchery trout had a very low hatch (<11% out of 600 eggs). For the entire data set, 5 hatchery trout had eggs with zero % hatch and 1 had <1% hatch. These trout from Henry's Lake are wild run fish and there are a number of other factors which may have influenced poor hatch in these fish, including poor fertilization. Eight egg batches had 56% or better hatch. By only examining normal and surviving fry from hatch to swim up, some data were by default removed from the analysis, as no fry were assessed at the thinning stage for some samples, if they had too few fry and were needed for the post swim up phase of the study. Censoring the additional two data points as done for the analysis ultimately used provided for a better overall model fit, a slightly more conservative EC10, and eliminated from the analysis "control" wild fish that had very poor hatching success, possibly due to poor fertilization.

(e.g., Hardy 2005, Hardy et al. 2010, Rudolph et al. 2008, Nautilus Environmental 2011, Holm et al. 2005).

For the purpose of this SSSC proposal, the survival EC_{10} for brown trout of 20.5 mg/kg dw egg selenium will be used for deriving the egg criterion value. This EC_{10} will be combined in the derivation process with other egg EC_{10} data from other species to derive an overall egg criterion. The derivation process is discussed in more detail in subsequent sections.

5.2 Field Monitoring

5.2.1 2006 to 2008

Seasonal monitoring was conducted from 2006 to 2008 to characterize the selenium exposure conditions and productivity (or health) of the aquatic community within the Study Area. During each monitoring event, locations were sampled for a range of chemical, biological, and physical characteristics. Activities conducted to document and evaluate existing conditions included collection of water, sediment, periphyton, benthic invertebrates, and fish tissues for chemical analyses of selenium concentrations. Benthic community, fish population and community, and physical habitat quality assessments were conducted. Fish communities were sampled to characterize their density and diversity. Physical habitat attributes were measured to document the qualities of habitat conditions that exist at each location. A complete characterization and analyses of these data is presented in the TSD (Formation 2012). A summary of the chemical concentrations measured in the different media from 2006 to 2008 are presented in Table 1.

Selenium in surface waters undergoes a consistent annual trend. The loading from Hoopes Spring does not show seasonal effects and is relatively constant in any given year. During high spring runoff, selenium concentrations typically decline while during the summer/fall low flow periods, selenium concentrations increase. This cycle repeats each year at each location. Because of the influence of physical habitat quality and quantity on the aquatic community, trout populations were evaluated relative to habitat characteristics. Sculpin population density and age class structure suggests that there is no difference in sculpin populations between high and low selenium concentration locations; rather, sculpin population density is more likely dictated by habitat conditions. While some specific habitat features are limiting the full potential of the fishery, the quality is not diminished substantially enough to negatively alter trout populations. Habitat quality data suggests overall, that good quality habitat is available, but external land uses exist that may limit the full range of the fishery potential.

5.2.2 Ongoing Monitoring

As part of other regulatory and programmatic requirements, Simplot has routinely sampled and compiled selenium concentration data in surface water for a number of locations. Concentrations of selenium at several of these locations have increased since 2008 reflecting the influence of groundwater discharged at Hoopes Spring on downstream surface waters. Temporal trends of selenium in surface waters at key locations are shown in Figures 5 and 6. It is important to note that while selenium concentrations in surface waters have increased since the time most of the data for the SSSC studies were collected, the effects thresholds have not changed.

Since 2008, Simplot has continued fish population monitoring at a subset of locations. Collectively, the fish population data set spans a period of 11 years; from 2006 to 2016. The fish communities at the monitoring locations vary, and are influenced by a number of factors including the quality and quantity of water, food, and habitat factors (such as stream gradients, channel sizes, and stream temperatures, among others). Given the diversity of physical habitats, variations in the fish community composition are to be expected.

Trout population standing crop (biomass in kilogram per hectare kg/Ha) data are illustrated in Figure 7. The figures show brown trout and YCT standing crop for each year for: (1) Crow Creek locations upstream of Sage Creek; (2) Hoopes Spring and Sage Creek; and (3) Crow Creek downstream of Sage Creek. In Crow Creek upstream of Sage Creek, brown trout biomass has fluctuated from as low as 9 and to as high as 100 kg/Ha over the 10-year period. This biomass estimate represents naturally changing conditions across upstream background locations where selenium concentrations are not elevated. In Hoopes Spring and Sage Creek, where selenium concentrations are elevated, brown trout biomass has ranged from just over 29 kg/Ha in 2015 to over 100 kg/Ha in 2006. Declining biomass estimates as early as 2012 may be indicative of potential selenium effects but it is unclear if other factors (described above) are not also contributing to the observed decrease. In Crow Creek downstream of Sage Creek, brown trout biomass has ranged from 43 kg/Ha in 2006 to 84 kg/Ha in 2012 and down to about 19 kg/Ha in 2016. In Crow Creek downstream of Sage Creek, selenium exposure is much lower than in Sage Creek, but still higher than background.

The Crow Creek locations upstream and downstream of Sage Creek show brown trout biomass estimates that are more similar to one another, while the Hoopes Spring and Sage Creek estimates are vary widely; showing a distinct decrease as of fall 2013. How much of this is related to selenium concentrations versus other environmental factors is unclear.

For the YCT (Figure 7), biomass estimates across all three groups of locations are relatively similar from 2006 to 2011. In 2012, the upstream Crow Creek YCT biomass declined, while the Hoopes Spring and Sage Creek, and downstream Crow Creek biomass increased. From 2012 to 2016, YCT biomass remained lower in the upstream Crow Creek locations compared to previous years. YCT biomass in 2012 was the highest observed over the monitoring period for Hoopes Spring and Sage Creek, and Crow Creek downstream of Sage Creek locations. From 2013 to 2016, YCT biomass for Hoopes Spring and Sage Creek, and Crow Creek downstream of Sage Creek locations appears to remain with the range of biomass estimates for those locations prior to 2012. It is unclear what factors affected the apparent shift in 2012 given the decline in biomass observed at background locations.

Because the standing crop estimates can be affected by the size and how many large fish are captured, a relative density estimate was also examined, not only for brown trout and YCT, but also for sculpin. Figures 8 and 9 show brown trout, YCT, and sculpin total density for each year at individual locations together with annual mean surface water selenium concentrations. Beginning upstream at Crow Creek sampling location CC-350, it is clear that the total selenium concentration in surface water is relatively low (<1.2 µg/L), and density estimates for all three species are relatively similar across years.

At the Hoopes Spring sampling location HS-3, while the record for each year is not complete, the available data do provide an indication of trends. Sculpin and YCT density estimates are relatively stable through time even though selenium increased to >80 µg/L in 2014 and later. Brown trout density estimates declined after 2012 to levels lower than initial estimates in 2006.

At Sage Creek (LSV-2C), sculpin density declined from 2006 to 2008, but rebounded in 2009 and increased steadily through 2013. Of the two trout species, brown trout are clearly dominant based on density until 2013, when YCT become more dominant. From 2011 to 2012 the surface water selenium concentration increased well above the annual averages from previous years and remained elevated from 2012 through 2016. A decline in brown trout density was observed in 2012. YCT density remained stable and increased in 2016. There is a fundamental shift in trout species dominance based on density which corresponds to increased and sustained higher concentrations of selenium in surface waters. It is important to note however, that these shifts and changes were not observed until annual selenium in surface water exceeded about 40 µg/L in Sage Creek. At Sage Creek (LSV-4) farther downstream, some of the fish population data are missing from 2007 to 2009 due to access issues, but the record is complete from 2010 on. Sculpin density appears consistent with Sage Creek upstream (LSV-2C), as do the brown trout and YCT density estimates.

At Crow Creek downstream of Sage Creek (CC-1A) a similar decline in brown trout density was observed after 2012; at about the same time annual average selenium concentrations in surface water increased. YCT density remained relatively consistent year to year in Crow Creek downstream of Sage Creek. Sculpin density showed an increasing trend over the 10-year period. Similar to Sage Creek, surface water concentrations of selenium increased starting in 2012.

The observed trends in brown trout density appear to correspond to increased surface water selenium concentrations. Overall, YCT and sculpin densities have remained relatively consistent at the different locations despite the increase in selenium concentrations in water, suggesting their relative insensitivity to selenium as compared to brown trout. This observation of field population trends is consistent with studies concerning effect thresholds indicating cutthroat trout and sculpins as being less sensitive than brown trout.

5.3 Literature

The literature has guided the development of the approach and design for this study. Initially, the literature was reviewed to examine the various approaches that have been used to evaluate selenium toxicity to aquatic life. Information from the literature has also been used to identify sensitive species of aquatic life, sensitive life stages, the most relevant pathways for evaluating potential effects, and effective measurement endpoints for evaluating toxicity. In the analysis phase of the evaluation, the literature continues to be reviewed to assess how results from this study compare to those of others. This step provides an important "reality" check in making determinations about data applicability, accuracy, and representativeness for the Site.

5.3.1 Fish

The most comprehensive review of the literature is compiled in the 2016 National Criterion (USEPA 2016a). It includes reviews and independent analyses of data from each study. Reproduction and non-reproduction studies are reviewed for cold and warm water fish, and information for non-fish aquatic species sensitivities are also described. Of the cold water studies, those that would be the most important for developing an SSSC for streams within the Site, EC_{10} values range from 21 (brown trout) to 56 (dolly varden char) mg/kg dw egg selenium (Table 2).

Brown Trout and YCT - Brown trout was the most sensitive salmonid tested. For the trout species, there was a relatively narrow range of effects thresholds. Westslope cutthroat trout had an SMCV of 26.2[11] mg/kg dw egg selenium, while rainbow trout were only slightly more sensitive at 24.5 mg/kg dw egg selenium. Studies by Hardy et al. (2005, 2010) indicated that there was no effect on survival or deformities for YCT at 16 mg/kg dw egg selenium, while the Formation (2012) studies, using the same species, indicated that the EC_{10} for surviving normal fry was 26.99 mg/kg dw egg selenium.

Other Trout Species - USEPA (2016a) evaluated the brook trout data from Holm et al. (2005) and suggested that the effect threshold is greater than 48.7 mg/kg dw selenium due to the absence of any consistent concentration-response relationship up to the maximum observed egg concentration. Pilgrim (2009) examined rainbow, brook, and cutthroat trout for deformities and survival from reproductive studies, but due to the relatively high variability of the concentration responses for the replicate data using the deformity endpoint, none of these data were considered in the criterion development. For the USEPA (2016a) analysis, the genus *Salvelinus* is represented by the dolly varden data generated by the Golder (2009) study. Considering the survival data from Holm et al. (2005) and Pilgrim (2009), an EC_{10} for brook trout survival of 32 mg/kg dw egg selenium can be derived. Thus the effects for brook trout may range from 32 to 48.7 mg/kg dw egg selenium.

Fathead Minnow - While USEPA (2016a) included the fathead minnow data from Schultz and Hermanutz (1990) as part of their "N" value for achieving 15 species, they did not include it in the

[11] The geometric mean of the EC_{10} values for westslope cutthroat trout.

reproduction studies distribution showing effects relative to egg selenium concentrations. Their rationale was that the uncertainty in the study was sufficient to not include it and an EC_{10} could not be determined from those data. USEPA (2016a) shows a lowest observed effects concentration (LOEC) for the Schultz and Hermanutz (1990) study of <25.6 mg/kg dw egg selenium meaning an EC_{10} would likely be lower than the LOEC value cited. This is inconsistent with much of the fathead minnow and cyprinid data suggesting cyprinids as a group are not particularly sensitive to selenium.

GEI (2008) data were also described but not utilized in the criterion derivation because USEPA (2016a) indicated that the high variability and lack of response made it difficult to derive an EC_{10}. GEI (2014) pointed out some of USEPA's inconsistencies in its use of some data sets versus others in its comments on the USEPA 2014 Draft Criteria document. GEI (2014) notes that USEPA used a generic egg to whole body conversion factor of 2 instead of the species specific conversion factor of 1.4. They further noted that deformity rates in their study do increase with increasing whole-body selenium exposure, consistent with other studies used by USEPA. GEI (2014) recommended a chronic value of 42.067 mg/kg dw whole body which was the lowest deformity response of the four evaluated. Converting to an egg concentration using a factor of 1.4 yields a chronic egg value of 58.89 mg/kg dw. USEPA (2016a) does cite the GEI (2008) data as well as Young et al. (2010) observations[12] to illustrate that fathead minnows are likely less sensitive than the LOEC based on the Schultz and Hermanutz (1990) study. A SMCV can be derived for fathead minnows by generating the geometric mean of the two EC_{10} values cited above, which equals 38.73 mg/kg dw egg selenium.

Sculpin - One study that was not submitted to USEPA for consideration in developing the 2016 National Criterion was by Golder and Nautilus Environmental (Nautilus) that examined the effects of dietary selenium on the reproductive capabilities of slimy sculpin (*Cottus cognatus*). These data were presented at the 34th Annual SETAC meeting by Lo et al. (2014). Dietary selenium effects in slimy sculpin were tested by Nautilus starting in 2011. Slimy sculpins were collected from the field and fed a selenium dosed diet for 7 months prior to being brought into spawning condition in the laboratory. They found that the no effect egg tissue concentration was 22.0 mg/kg dw selenium in adult slimy sculpin and that the effect threshold was greater than 22 mg/kg dw.

[12] Fathead minnows remained after selenium contamination eliminated most other fish species from Belews Lake, including bluegill sunfish and largemouth bass.

The highest whole body tissue measured in Lo et al. (2014) was 11 mg/kg dw. Thus the EC_{10} is at some concentrations greater than 22 mg/kg dw egg selenium.

White Sucker - White sucker sensitivity to selenium was examined by de Rosemond et al. (2005) using field collected organisms from an area in northern Saskatchewan. While limited data were available, USEPA's (2016a) review suggested that embryo/larval effects are not observed at concentrations in eggs reaching 40.3 mg/kg dw (geometric mean of the two high selenium concentrations in eggs). This species was not included in the 2016 National Criterion development because it was based on a small data set with no controls. It is clear, however, that a no effects level can be estimated sufficient for inclusion here as white suckers are found at the Site.

For most studies reviewed, deformities and/or survival were the common endpoints. In almost all of the studies reviewed, the dose response was steep, and the effects were best correlated to egg selenium concentrations.

5.3.2 Invertebrates

Overall, the literature suggests that reproductive endpoints in fish tend to be a sensitive indicator of excessive selenium and that invertebrates are less sensitive to selenium effects than fish. Long-term studies of benthic macroinvertebrate response to selenium exposure are few. Swift (2002) conducted long term (>1 year) experimental dosing studies on stream mesocosms and found no significant effect on benthic community abundance, diversity, or richness in the high (30 µg/L nominal) and moderate (10 µg/L nominal) experimental units, but *Tubifex* and Isopod numbers were reduced.

deBruyn and Chapman (2007) examined the literature to assess selenium sensitivity of macroinvertebrates and found that some invertebrates may be sensitive at body burdens similar to those protective of fish. USEPA (2016a) identified and reviewed three invertebrate studies that included dietary exposure for invertebrate species from which EC_{10} values could be derived. USEPA (2016a) derived an EC_{10} of 37.84 mg/kg dw for the rotifer, *Brachionus,* from the Dobbs et al. (1996) study and an effect level >140 mg/kg dw for the oligochaete, *Lumbriculous.* USEPA (2016a) also reviewed and presented findings of the Conley et al. (2009, 2011, and 2013) studies.

Conley at al. (2009, 2011, and 2013) published a series of studies for the mayfly, *Centroptilum.* Conley et al. (2009) conducted a dietary feeding study on uptake of selenium in mayflies. Measureable effects on fecundity were found at dietary concentrations of selenium less than 11 mg/kg. The diet was comprised of algae which concentrate selenium at several times the abiotic concentrations and also convert selenium into more bioavailable methylated forms. Conley et al. (2009) demonstrated that, like fish, benthic invertebrate exposure to, and effects from, selenium are based on the dietary intake. Using the BAF of 2.2 provided by Conley et al. (2009), the 11 mg/kg dietary value corresponds to an adult mayfly tissue selenium concentration equal to 24.2 microgram per gram (µg/g) dw. In subsequent work, Conley et al. (2011) found that bioaccumulation and influence of selenium on mayfly performance may be tied to resource availability and quantity. Conley et al. (2013) reported a bioaccumulation or trophic transfer factor of 2.1 and defined secondary reproductive effects at a dietary concentration of 12.8 mg/kg dw, thus supporting their earlier work that effects occur at dietary concentrations greater than 11 mg/kg dw. Again, using the BAF and applying that to the dietary concentration of 12.8 mg/kg dw, a whole body tissue threshold of 26.9 mg/kg dw was derived. USEPA (2016a) translated the Conley et al. EC_{10} of 24.2 to a median whole body concentration at trophic level 3 to 29.3 mg/kg dw.

The prevailing scientific evidence supports the current thinking that effects to developing fish are among the most sensitive aquatic biological indicators of excessive selenium exposure (USEPA 2004; Lemly 1996; Ogle and Knight 1996; Skorupa et al. 1996; Janz et al. 2010). This would suggest that if the biological response of fish is considered a very sensitive indicator of effects, fish species would be considered a sensitive aquatic receptor.

5.3.3 Amphibians

Recent reviews of scientific literature suggest that amphibians are less sensitive to the effects of metals than are fish (Kerby et al. 2010, Weltje et al. 2012). Kerby et al. (2010) evaluated a large number of exposure and toxicity tests including invertebrates, fish, and amphibians and found that amphibians may be less sensitive than other aquatic biota.

Weltje et al. (2012) conducted a comparative analysis of acute and chronic sensitivity of fish and amphibians for approximately 50 chemicals, including some metals, but mostly organic chemicals. Of the chemicals evaluated, the only metals evaluated were cadmium, copper, and zinc. The study compared chronic no observed effects levels (NOELs) reported in the literature and/or regulations of various agencies. They found that amphibian NOELs were generally higher than sensitive fish species. The authors concluded that NOELs and water quality criteria generated for fish species will be generally protective of amphibians. They also concluded that additional amphibian testing may not be necessary for chemical risk assessment.

An overall conclusion from Kerby et al. (2009) and Weltje et al. (2012) is that amphibians are generally less sensitive than fish or other aquatic organisms to a broad range of environmental contaminants in water. However, neither of these reviews included dietary pathways that are important for exposure of aquatic vertebrates to selenium. Hopkins et al. (2006) examined developmental effects of selenium accumulation in maternal adults and transfer to developing embryos in eastern narrow-mouthed toads (*Gastrophryne carolinensis*). Female adult toads would have obtained most of the selenium body burden through dietary pathways. Similar to fish, selenium accumulated by the maternal parent is transferred to eggs and can affect developing young. The highest selenium accumulation in eggs (up to 80 to 100 mg/kg dw) was substantially higher than for trout eggs. Egg viability was higher, and deformities were lower (96 hour) than for reference eggs for all but one endpoint (craniofacial). These data suggest that *G. carolinensis* embryo development is less sensitive than brown trout to selenium in eggs. However, small samples sizes at the higher concentrations may have affected the ability to detect statistical differences. Interpretation of the Hopkins et al. (2006) study reveals an estimated NOEL threshold value of approximately 20 mg/kg dw[13] can be derived.

Unrine et al. (2007) evaluated metal concentrations in mollusks, insect larvae, bullfrog tadpoles, and fish collected from a coal-ash affected swamp area of the United States Department of Energy Savannah River Site in South Carolina. Bullfrog tadpoles (*Rana catesbeiana*) accumulated between 1 and 4 times higher concentrations of several metals than other invertebrates and fish. For selenium, concentrations (whole body) in tadpoles were marginally higher (approximately 1.5

[13] When all developmental criteria were considered collectively, offspring from the contaminated site experienced 19% lower viability, although egg selenium concentration and egg viability were not statistically related (Hopkins et al. 2006). While a true effects threshold related to amphibian body burdens was not derived in this study, there was a demarcation of effects relative to controls at the contaminated sites. The mean value of 42.4 mg/kg dw in whole body tissues has a large degree of uncertainty associated with it based on the standard error presented. The mean value (n=10) for the contaminated sites was based on data spanning a wide range of body burdens and Hopkins et al. (2006) state that their statistical power for detecting functional relationships between concentrations and effects was probably limited within the range of concentrations where effects should be predominant (e.g., egg selenium concentrations > 20 mg/kg dw).

times) than concentrations in aquatic insect larvae (dragonfly genera *Tramea* and *Erythemis*), smallmouth bass (*Micropterus salmonoides)* and spotted sunfish (*Lepomis punctatus*). The swamp site from which these data were collected is a lentic system, and the pattern of relative concentrations among these groups may not be comparable to the lotic systems at the Site. However, the similar concentrations among the tadpoles and other aquatic biota suggest that anuran amphibians will not bioaccumulate selenium at substantially higher levels than the brown trout at the Site.

In a more recent study, Masse et al. (2015) derived an EC_{10} for the *Xenopus laevis*; a toad that is a standard test species in the Frog Embryo Teratogenesis Assay *Xenopus* (FETAX) toxicity assessment procedures. USEPA (2016a) reviewed this study and reports the authors EC_{10} values for abnormal spinal curvature, abnormal craniofacial structure and abnormal lens structure were 57.3, 38.4, and 34.5 mg/kg Se egg dw, respectively. The study identified an EC_{10} value of 44.9 mg/kg dw in eggs for total deformities.

6.0 DEVELOPMENT OF A SITE-SPECIFIC SELENIUM CRITERION

The 2016 National Criterion is derived from a distribution of different selenium concentrations (e.g., EC_{10} values) in egg/ovary tissues based on survival and/or deformities according to the methods found in Stephan et al. (1985). There are minimum data requirements (MDRs) to be met (N=8) in order to provide sufficient types of acceptable aquatic toxicity data for developing a criterion outlined in Stephan et al. (1985) that are described in detail in the 2016 National Criterion. The 2016 National Criterion exceeds the MDRs with an N = 15 and the brown trout data are the 3rd most sensitive species/genera of the 15 cited GMCVs for reproductive effects (USEPA 2016a). Table 3 shows all 15 genera used to derive the 2016 National Criterion. Eight fish egg/ovary thresholds were utilized at the genus level (Figure 3.1 of the 2016 National Criterion). Both fathead minnow data and *Gambusia* were included in the total N for a total of 10 GMCVs. Three invertebrate thresholds were also included for a total of 13 GMCVs. Two of the fifteen were waived as non-existing, non-essential values for invertebrates. Page 59 of the 2016 National Criterion explains this waiver.[14]

6.1 Egg Criterion

The key threshold for developing this SSSC is the brown trout EC_{10}. USEPA (2016a) utilized Simplot's brown trout data and derived an EC_{10} of 21 mg/kg dw egg selenium based on survival from hatch to swim up. Simplot derived their own EC_{10} from the brown trout survival data using the full set of data (e.g., hatch to test termination), which was 20.5 mg/kg dw egg selenium. Two slightly different compilations of the brown trout survival data yielded two EC_{10} values that are remarkably similar and toxicologically not different. The approach and rationale for both the USEPA and Simplot EC_{10} derivations are described at length in USEPA (2016a) Appendix C and Simplot's Draft manuscript in preparation for publication, *Effects of in situ selenium exposure and maternal transfer on the survival of brown trout (Salmo trutta) fry.*[15], Simplot's EC_{10} for brown trout

[14] Because the 5th percentile calculation methods for the FCV use actual numerical values for the GMCVs of the four most sensitive (fish) genera in the selenium dataset, it is only necessary to know that the more tolerant genera have GMCVs that are greater than those of the lowest four. A recommendation in the draft white paper on Aquatic Life Criteria for Contaminants of Emerging Concern Part I (U.S. EPA 2008b), which was supported by the Science Advisory Board, states "because only the four most sensitive genus mean chronic values (GMCVs) are used in the criterion calculations, chronic testing requirements for a taxon needed to meet an MDR should be waived if there is sufficient information to conclude that this taxon is more tolerant than the four most sensitive genera."

[15] This draft manuscript can be provided upon request.

was used for this SSSC proposal and it is the most sensitive value in the compilation of species for the Site.

Table 3 shows the species and ranks of the data utilized to derive the 2016 National Criterion as well as the criterion derivation process. Note that the GMCVs were used for some taxa. Table 4 shows the species and ranks used to derive the SSSC for the Site. For the SSSC, SMCVs were used. This was done primarily because on a site basis, the number of taxa available for use as resident and surrogate become much smaller than on a National scale. This is particularly true for small mountain streams which typically do not have diverse fish species assemblages.

The taxa compiled provide a representative species distribution for the Site which includes trout species, cottids, cyprinids, catostomids, an amphibian, and invertebrates. As with the 2016 National Criterion derivation, a SSSC relies on the four most sensitive species, in this case brown trout, rainbow trout, westslope cutthroat trout,[16] and YCT.

Using the derivation method of Stephan et al. (1985), which is consistent with USEPA (2016a) derivation procedures, a species list of N=14 was compiled, and the four most sensitive taxa were used to derive the criterion. Based on the calculation procedure shown in Table 4, the SSSC for egg ovary is the 5th percentile estimate of the species distribution equal to 19.9 mg/kg dw egg selenium. The egg selenium concentration of 19.9 mg/kg dw is proposed as the egg SSSC value protective of the aquatic life present in Hoopes Spring, Sage Creek, South Fork Sage Creek, and lower Crow Creek.

6.2 Whole Body

USEPA (2016a) went through a similar process for deriving their whole body tissue criterion as they did for the egg/ovary derivation. However, that process addressed species on a National scale, whereas this process addresses a site-specific scale where the most sensitive species is resident (i.e., brown trout) and is the species that will be monitored for compliance. By using the USEPA (2016a) approach for deriving the egg criterion, which included an assemblage of

[16] Westslope cutthroat trout are not found at the Site; however, it is a salmonid which is primarily an insectivore. It is retained as a surrogate species for another salmonid insectivore species, mountain whitefish, for which no test data are available. While mountain whitefish are not expected to be as sensitive to selenium as westslope cutthroat trout, it is retained as a conservative measure in deriving the SSSC.

species, the egg criterion derived is protective of Site species. Further, selenium accumulation in the eggs of the exposed adult female prior to spawning has been shown to yield the most robust relationship (statistically significant) with occurrence of deformities and reduced survival of the offspring (USEPA 2016a). Site specificity and the best cause and effect relationship being for egg tissue and deformities and/or reduced survival is powerful evidence that supports a direct calculation of the whole body criterion element from the egg criterion element derived above.

Because the relationship for egg/ovary concentrations to whole body selenium concentrations has been established for brown trout from this Site, it is the most relevant and direct approach for deriving a whole body criterion for an SSSC. USEPA (2016a) derived a whole body tissue concentration for brown trout of 13.2 mg/kg dw using Simplot's brown trout data. This value is based on the no-effect concentration from the brown trout reproductive study where the associated egg value was 20.5 mg/kg dw[17]. Thus, the whole body tissue value of 13.2 mg/kg dw is a no-effect threshold from USEPA (2016a).

Based on the site-specific data, and using the procedures outlined in USEPA (2016a), the brown trout conversion factor (CF) for egg to whole body is 1.45.[18] Applying the CF to the egg EC_{10} (20.5 mg/kg dw) yields a value of 14.14 mg/kg. Additional data are available for this Site collected just prior to the field work done for the brown trout study (Table 5). Six additional egg and whole body tissue pairs of data were collected in late October 2007 during the first attempt to collect ripe females. The six females were believed to be ripe and were sacrificed to determine if eggs were present. In each, eggs were present and excised. Separate egg and whole body tissues samples were submitted for chemical analyses. The ratios from these six additional samples fall within the range of egg to whole body ratios derived from the fish used in the reproduction study (Table 5). Addition of the six pairs of data results in an N=40 for the derivation of CFs. The median value for all of these Site data is 1.46 (±0.67). In this case, the standard deviation for the CF using only data developed for this study (including those collected as preliminary samples) is considerably lower than the USEPA (2016a) standard deviation of 1.81 that included the Osmundson et al.

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[17] The value 20.5 mg/kg dw is the egg concentration cited as no effects with a corresponding maternal whole body tissue concentration of 13.2 mg/kg dw. These are the measured values from the brown trout study.

[18] The value 1.45 is derived as the median CF of all the paired brown trout whole body and egg tissue values from Simplot's brown trout studies and Osmundson et al. (2007). Inclusion of the Osmundson et al. (2007) data introduces CF data from outside the Site, but more importantly, those data are for whole body and ovaries.

(2007) data. Based on these data, the CF proposed for the SSSC is 1.46. Dividing the proposed egg criterion (19.9 mg/kg dw) by the CF (1.46) yields a whole body criterion of 13.63 mg/kg dw selenium. The proposed SSSC value for whole body tissues is 13.63 mg/kg dw.

6.3 Water

According to USEPA (2016a), a protective water concentration may be developed from the site-specific egg/ovary, whole body, or muscle criterion elements and translation of the fish tissue criterion to a protective water concentration can be performed in a manner that accounts for site-specific conditions. There are some limitations, however, as only two approaches for developing a protective water concentration from tissue thresholds are offered as valid approaches. These are use of a mechanistic approach (Presser and Luoma 2010) to model selenium through the food chain, or use of an empirical BAF approach. Appendix K of USEPA (2016a) outlines the two approaches and discusses their advantages and disadvantages.

6.3.1 Mechanistic Trophic Model

The mechanistic model approach is considered to be more comprehensive, but due to its many steps (i.e., trophic levels) it can be more uncertain. The primary uncertainty arises in the enrichment factor (EF) portion of the model. EFs can vary widely, as it is a ratio of algae, detritus, and sediment to water which can vary over time. Further, concentrations of sulfate have been shown to affect selenium uptake and the resulting bioaccumulation in freshwater organisms, including algae (Brix et al. 2005, Ogle and Knight 1996, Williams et al. 1994). For the purposes of this SSSC, all inputs for the mechanistic model were derived from samples collected on Site; thus the model is empirically based. The data, methods, assumptions, and calculations used to derive a water element from the egg criterion are presented in Appendix B.

A protective water selenium concentration was derived using both methods because sufficient data were available to evaluate the similarity or dissimilarity between them. Using the mechanistic trophic model, protective water concentrations were derived using data compiled from 2006 to 2011 for two conditions: (1) Site streams – spring, summer/fall seasons, and (2) Site streams – summer/fall seasons. For this dataset, the number of paired samples (water, sediment, periphyton, benthic invertebrate, sculpin, and trout) results in an N=36. Where multiple fish tissue samples were collected for a location and time period, the arithmetic mean was used as the representative concentration.

Using the egg ovary value of 19.9 mg/kg dw as the basis, the dissolved water concentrations allowed such that the egg criterion is not exceeded are 12.99 µg/L (Site streams – all seasons) and 13.20 µg/L (Site streams – summer/fall seasons). Application of a dissolved to total metal translator (0.98) derived from paired total and dissolved selenium concentrations in surface waters from all Site sampling locations yields total selenium concentrations of 13.26 and 13.47 µg/L for Site streams – all seasons, and Site streams – summer/fall seasons, respectively.

Figure 10 shows the relationship of predicted dissolved selenium from the mechanistic model versus the actual measured dissolved selenium concentrations. Overall, the linear relationship (R2 = 0.895) indicates strong predictive power of the model using the site-specific inputs. Despite this relationship, it is clear that the variability increases in the relationship as selenium concentrations increase. The model sometimes over or under predicts the actual dissolved concentration, in some cases by a large margin (>10 µg/L) as selenium increases. The multiple trophic steps in the mechanistic model allow for introduced variability at each step. As selenium concentrations in the surface waters increase, the variability in each trophic accumulation step may also increase. For this SSSC proposal, this became important because selenium concentrations in surface water of the Site often exceed 10 µg/L, which may affect subsequent selenium bioaccumulation and integration into higher levels of the food chain.

6.3.2 Empirical BAF Model

The empirical BAF approach relies on a site-specific, field measured BAF (i.e., selenium tissue concentration divided by dissolved selenium concentration in surface water). It is a direct measure of selenium bioaccumulation into fish, without the trophic steps and requires no assumption on dietary intake. The BAF approach uses site-specific ratios developed that are not intended for use in other watersheds.

The BAF approach relied solely on brown trout data collected from locations within the Site (Hoopes Spring, Sage Creek, South Fork Sage Creek, and Lower Crow Creek). Individual BAFs were derived for each trout tissue concentration and dissolved selenium concentration for a location and time period, resulting in a dataset of N=294 samples. Recall that the BAF is simply the tissue concentration divided by the dissolved water concentration. Multiple trout were captured for analysis at each location, while only a single water quality sample was collected, thus a range of BAFs were derived for each location and time period. The dataset for the BAF approach spanned the time period from 2006 to 2011[19] (Appendix C). Figure 11 included two figures, one illustrating the whole body selenium concentrations relative to the dissolved selenium concentrations for the dataset and the second showing the derived BAFs versus dissolved selenium concentrations in surface waters. The BAFs derived are based on whole body tissues, whereas the criterion is based on egg tissues. Whole body tissue concentration BAFs were converted to egg concentration BAFs to derive the allowable concentration that would not exceed the 19.9 mg/kg dw egg selenium criterion and be comparable to mechanistic model output.

$$BAF_{egg} = (C_{tissueWB} * CF)/C_w$$

Where: BAF_{egg} = BAF equivalent for egg tissues

$C_{tissueWB}$ = Tissue concentration of selenium whole body brown trout (mg/kg dw)

CF = Conversion Factor ratio for egg to whole body

C_w = Concentration of dissolved selenium in surface water (µg/L)

To derive the water concentration for each of the scenarios, a median BAF was derived, and the egg concentration of 19.9 mg/kg dw egg selenium was divided by the median BAF.

For the Site streams - all seasons, the derived dissolved selenium concentration was 12.34 µg/L, while for the Site streams - summer/fall seasons, the derived dissolved selenium concentration was 13.28 µg/L. Translated to total selenium, the values are 12.59 and 13.55 µg/L, respectively.

6.3.3 Site-Specific Water Value

A logical expectation is that when using site-specific inputs for a mechanistic model approach and site-specific BAFs, the model outputs (e.g., predicted surface water concentrations) should be very similar. If the output from the two approaches is similar, then it suggests that the data

[19] Data from 2013 were not included in the BAF calculations because the resulting BAFs at some locations were substantially different than the range of BAFs derived during the 2006 to 2011 time frame. By limiting the BAFs to 2006 to 2011 time frame, the BAF dataset is more comparable to the mechanistic model data set spanning the same time period.

collected and model assumptions utilized likely provide a representative assessment, and that either method could be used as one serves as a check for the other approach. If the outputs are not similar, it suggests that the variability of the input data may result in uncertainties that should be evaluated.

Total selenium concentrations of 13.26 and 13.47 µg/L were derived for the Site streams – all seasons and Site streams – summer/fall seasons, respectively, using the mechanistic model. Total selenium concentrations of 12.59 and 13.55 µg/L were derived for the Site streams – all seasons and Site streams – summer/fall seasons, respectively, using the BAF approach. About 1 µg/L or less separates the predicted values output from the two different models. Therefore, it is concluded that both approaches are equally effective in generating a protective selenium concentration in water for this Site using the site-specific inputs and assumptions. Based solely on the ease of data collection for future evaluations, this SSSC proposal recommends that the water value be based on the BAF approach for the Site streams - summer/fall seasons. The summer/fall seasons are when selenium concentrations in water are highest and bioaccumulation is likely greatest. It is also the time period prior to brown trout spawning when egg formation and selenium deposition occurs. Timing the water value to a sampling period and zone is expected to provide a conservative estimate of fish tissue concentrations for compliance monitoring using a sensitive species.

USEPA's (2016a) water value is based on the 20th percentile of a range of either lotic or lentic water concentrations from across the United States. For lotic waters, the 20th percentile value is 3.1 µg/L. This type of approach is needed because the 2016 National Criterion water concentration is applied across a broad range of conditions, species, landscapes, and regions. For this SSSC, there is no need to derive a 20th percentile, because the water value in this proposal is derived from an egg criterion based on a representative species assemblage with the most sensitive species data being generated from the site-specific threshold for brown trout which were exposed to a very distinct range of selenium concentrations in water and prey items. These data originate from the locations where the criterion will be applied and where future monitoring for compliance will occur. The site-specific water value derived from the egg criterion is 13.55 µg/L total selenium[20].

[20] The summer/fall data best simulates the time period when maternal adult brown trout will be accumulating dietary selenium just prior to any deposition to eggs if selenium is in excess.

7.0 PROPOSED CRITERION IMPLEMENTATION

Elevated selenium concentrations at the Site are a result of releases due to historical mining activities at the Smoky Canyon Mine. Overburden materials removed to access the phosphate ore were placed in external overburden disposal areas (ODAs) or used to backfill mining pits. Selenium released to these materials infiltrates into underlying Wells Formation groundwater and transported with groundwater to spring discharges to surface water (i.e., Hoopes Spring and South Fork Sage Creek Springs).

Under CERCLA, Simplot has implemented two early remedial actions at Pole Canyon, which have significantly reduced releases of selenium to the surrounding environment. In addition, Simplot is implementing a pilot study water treatment system at the springs that is predicted to reduce selenium concentrations throughout the Site. Remedial actions at the mine will reduce selenium concentrations in surface water over time to meet the selenium criterion (the expected timeframe will be documented in the ROD).

USEPA's guidance documents (e.g., USEPA 2016b;_c;_d;_e) for implementing the 2016 National Criterion are draft pending public review. Changes that may result from this review and the potential effect on this implementation plan are unknown. The implementation plan proposed herein is relatively consistent with current draft USEPA implementation plan documents.

Appendix D provides a detailed implementation plan for the Site which is summarized in this Section and illustrated in Figure 12. While egg tissue has been demonstrated to be one of the most important endpoints to measure the effects of chronic exposure to selenium, it is not the most practical to monitor. A more practical and efficient monitoring approach, which effectively utilizes the criterion elements, would begin with monitoring the water column element of the criteria. Routine monitoring for surface water concentrations of selenium is already conducted as part Smoky Canyon's Comprehensive Environmental Monitoring Program. If the surface water monitoring indicates an exceedance of the water criterion, then more comprehensive whole body tissue monitoring would be completed or Simplot may pursue egg tissue monitoring. Compliance with the egg tissue criterion is the ultimate compliance mechanism, but the whole body tissue criterion may be used if it is not practical to obtain egg tissue data. In the event that no fish are present at a location, the nearest downstream location where fish are present would be examined to assess if the tissue data indicate an exceedance. In this proposed approach, the egg criterion would still take precedence over whole body tissue or water elements of the criterion when egg tissue data are available. The whole body tissue data take precedence over the water element of the criterion when whole body tissue data are available.

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